Interactive Two-Handed Virtual Design

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Abstract

This paper introduces *VSCAPE*, a virtual environment for intuitive, hand-based terrain design. We present a design environment that provides an intuitive interface for the creation and manipulation of 3D scenes as required for terrain, game-level and set design. *VSCAPE* was developed to provide the user with maximum design flexibility while providing a small, yet powerful set of easy-to-use tools and functions.

Keywords: Digital Design, Virtual Reality, Immersive Environments

1. INTRODUCTION

Virtual environments (VEs) are being used for industrial product design, analysis and verification tasks, medical imaging, architectural walkthroughs, geo-scientific exploration and sculpting. *VSCAPE* combines data analysis, designs and verification capabilities of these environments and applies them to scene design suitable for urban planning, game-level design and set design.

Modeling environments traditionally rely on the use of polygonal, volumetric or mathematically defined primitives. Since primarily developed for the interactive design of terrains, *VSCAPE* is currently surface-based and supports hand-based sculpting, painting and texturing on a polygonal level. For this type of application the goal was to "think visually" in terms of shapes, colors and textures instead of vertices, edges or curves and surfaces. As a consequence, the modeling concept is different from traditional keyboard and mouse centered computer based design and closer to traditional hands-on modeling. The user is equipped with a set of spatially tracked gloves and can employ a head-mounted display, immersive workbench or standard monitor-based stereo to create a 3D scene (Figure 1). The core design criteria was to provide technical and non-technical users with an easy-to-use environment, for the creation of realistic environments. At the same time it was important to offer an unconstrained interface to the user that reduces or removes the pre-meditative design phase. This was accomplished by providing an environment that fosters the use of built-in verification tasks and the development of "game strategies" as part of the design cycle, resulting in a thoroughly developed and tested final product. Visibility, reachability and accessibility controls are built-in features that are automatically used throughout the design cycle. Relevant viewpoints or paths can be created as required and revisited throughout the design cycle for verification tasks.

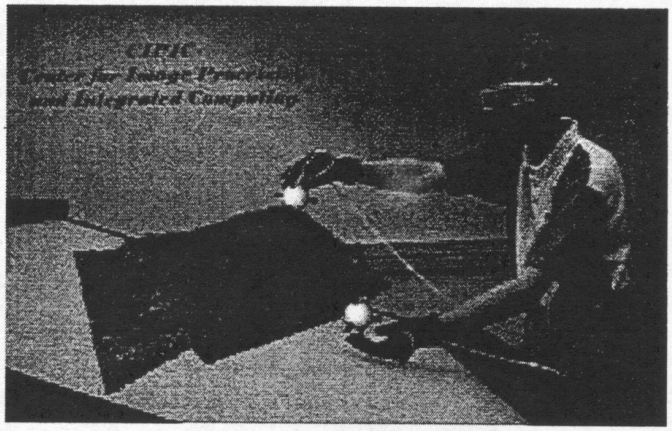

Figure 1: Terrain modeling and verification

2. IMPLEMENTATION

The observation that humans develop certain patterns on how to distribute tasks between their hands has lead to the development of two-handed interfaces supporting this natural dexterity. Most of these interfaces are based on spatially tracked input devices, such as data gloves and pointers. *VSCAPE* uses a set of spatially tracked pinch gloves, which can be used to navigate and manipulate the environment. This hand-based modeling approach provides access to efficient sculpting and painting metaphors that enable efficient and effortless expression of design ideas.

Furthermore, *VSCAPE* is based on an object-oriented design approach, which treats every visual component within the VE as an object that can be freely positioned, manipulated, verified, analyzed and visualized. Once an object is created, its visual representation is added to a hierarchical scene graph. All visible objects contained in the scene graph can be selected and their properties visualized using a simple hand gesture. Special behavioral actions can be attached to any object and turn

it into a tool for the manipulation of other objects. Any regular object within the scene graph can be directly accessed, scaled, translated, rotated, cloned and grouped.

Virtual Menus

Menus are a vital component of all modeling systems since they provide access to the available system functions. With the transition from a 2D to a 3D environment, a new set of VR input devices and consequently new concepts must be implemented. Different solutions to this problem were proposed during recent years opting for either a direct port from the classical 2D menu to its 3D counterpart or new implementations designed specifically for 3D space [4]. Commonly observed problems are interference between the 3D menus and the scene and sub-menu access in highly cascading menus. We distinguish between gesture-based trigger and invocation events that allow the user to activate and select from various menus. A simple pinch gesture gives the user access to a base menu, which can be freely positioned in the VE. The menu is composed of 3D buttons assembled on a rectangular palette. All the sub-menus are opened within this original palette and can be traversed using simple hand gestures. Following our original design philosophy, all menus are implemented as objects that can be translated, rotated and scaled as desired. The menu items can apply associated functionality to other objects when activated and be represented as text, a graphical presentation of the associated function or a combination thereof.

Terrain Creation

VSCAPE provides a variety of mechanisms for the interactive creation and manipulation of terrain data. Terrain information can be either imported in polygonal form from a file or interactively created by using drawing primitives or freeform shapes and manipulated with a suite of virtual tools. Based on the desired terrain, game level or set, the design cycle can start at different levels from either a planar surface, artist sketch, a blueprint or even a satellite image mapped onto either a surface, 3D model or other types of geometry. Arbitrary polygonal objects can be used to provide additional scene contents. Application-specific modeling libraries are supported and provide access to a wide range of primitives. These objects can be accurately positioned above the terrain using a rod level and then attached by simply dropping them onto the scene. User-definable objects and libraries including components such as houses and bridges are easily added through customizable menus, allowing the creation of additional scene contents. These objets can be accessed through the virtual toolbox and configured or extended to meet application specific demands. After invoking the virtual menu and selecting the appropriate object library, the chosen object can be simply grabbed and positioned on the terrain where desired. The application supports a "snapping mechanism", which enables accurate object placement onto the defined terrain. Objects automatically snap to the surface and can easily be cloned, moved, scaled, rotated or planted with a simple gesture. These libraries let the user design a scene, while immersion enables real-time verification. *VSCAPE* reads and writes most of the standard file formats, including flt, wrl, 3ds and dxf among others.

Object Selection

This operation is the starting point for a variety of interaction tasks. The basic idea is to use a 3D input device to select the closest object to a spatial position. When a device-specific action is invoked in the form of a particular state event the absolute position of the tracker is mapped too world coordinates. The data gloves are visualized with virtual proxies. When the proxy intersects the bounding box of a particular object, the object is highlighted and ready for selection.

Object Manipulation

Once an object is selected it can be rotated, translated, scaled, cloned, re-shaped, grouped, deleted, or otherwise manipulated.

Scene Verification

Design verification tasks such as visibility, reachability and accessibility, are frequently encountered during evaluation tasks. In our environment, they are built-in and are automatically used throughout the design cycle. If required, relevant viewpoints can be stored and visited as desired.

3. TOOLBOX

The virtual toolbox merges the advantages of conventional physical tools and unconstrained virtual tools with the natural dexterity of a two-handed design environment. Instead of merely defining tools, we define actions and functionality, which can be associated with a set of geometrically defined modeling primitives provided as part of the toolbox or any object in the scene. Thus giving the user unlimited space for creativity and the means for the creation of new tools and design concepts. In our object-oriented framework, tools can be used to shape models, which subsequently can be turned into tools on their own. The virtual toolbox of *VSCAPE* includes these types of tools:

Brushes, Filters, Manipulators, Magnets, Rulers, Stamps, Smoothers, Tesselators, Simplifiers and Object Libraries.

4. REFERENCES

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